

# Applied Technology and Engineering, P.C.

545 Panorama Road  
Earlysville, VA 22936



Website: [www.atandepc.com](http://www.atandepc.com)  
email: [wgoneal@atandepc.com](mailto:wgoneal@atandepc.com)

Phone: (434) 249-6443

---

January 15, 2021

U.S. Environmental Protection Agency  
Office of Ecosystem Protection  
EPA/OEP NPDES Applications Coordinator  
5 Post Office Square - Suite 100 (OEP06-03)  
Boston, MA 02109-3912

Ref: 2020 Gris WWTP Annual Compliance Report

Sent by Email: [R1NPDES.Notices.OEP@epa.gov](mailto:R1NPDES.Notices.OEP@epa.gov)

To Whom it May Concern:

On behalf of Barnhardt Manufacturing Company, the following report is provided as required by NPDES Permit No. MA0003697 Part 1.B.2 to detail progress towards meeting the final permit limits for phosphorus, copper, and toxicity. A three-year compliance schedule for these parameters was provided in this permit. Compliance with the limits for these parameters is proposed by February 28, 2021.

## Phosphorus

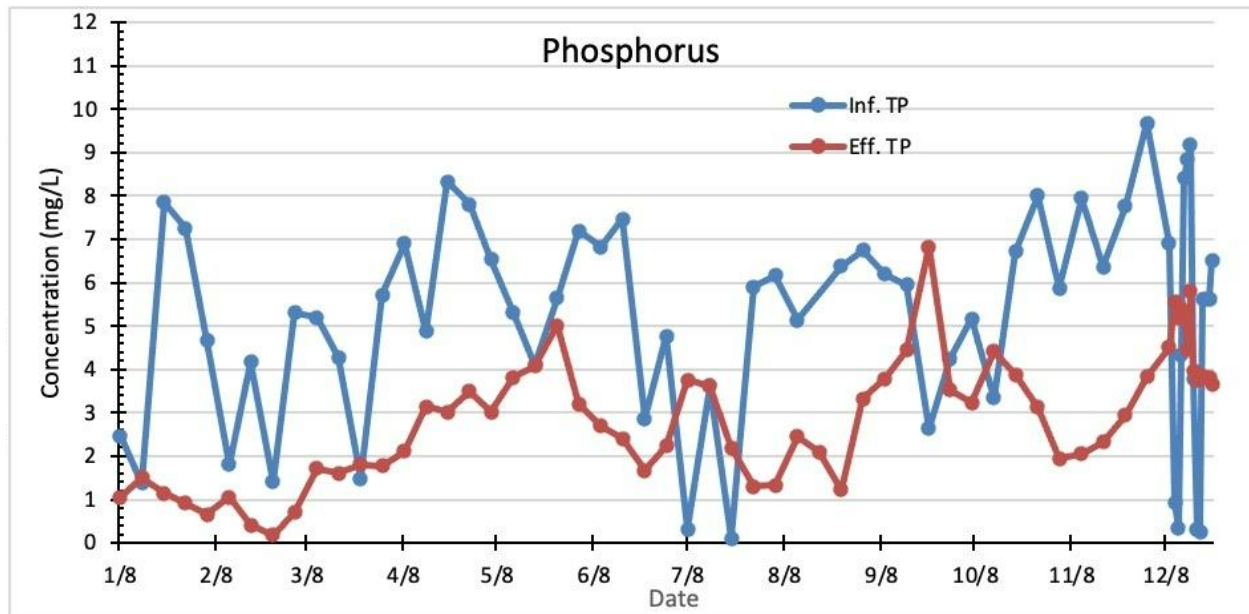
Currently, Barnhardt is required to only report effluent total phosphorus concentrations. However, the seasonal limit of 1.26 mg/L for May through October will be in effect at the end of the compliance period.

Influent and effluent total phosphorus (TP) concentrations are shown in Figure 1. Data used are shown in Appendix A. The average influent TP concentration was 5.14 mg/L and the average effluent concentration was 2.99 mg/L. Effluent TP and orthophosphate (PO<sub>4</sub>) concentrations are shown in Figure 2. It is observed that on average, 87% of the effluent TP is soluble PO<sub>4</sub>. Since PO<sub>4</sub> is amenable to precipitation using aluminum salts, laboratory trials were conducted to determine phosphorus removal using alum, aluminum chlorohydrate (ACH), and polyaluminum chloride (PAC). The results are shown in Table 1 and Figure 3. Alum appeared to be the most effective. At a dosage of 200 mg/L, both TP and PO<sub>4</sub> were reduced well below the permit limit with values <0.1 and <0.023 mg/L, respectively.

Additional work was performed to determine phosphorus removal with the addition of alum to the mixed liquor suspended solids (MLSS). Results are shown in Table 2 and Figure 4. An alum dosage of 200 mg/L reduced the TP concentration to 0.49 mg/L, below the permit limit.

In addition to treatment alternatives, work was done to identify chemicals used in manufacturing that contained phosphorus. The only chemical found to contain significant amounts of phosphorus was a boiler treatment chemical. This chemical was replaced in mid-August 2019.

**Figure 1. Influent and Effluent Total Phosphorus Concentrations**



**Figure 2. Effluent Total Phosphorus and Orthophosphate Concentrations**

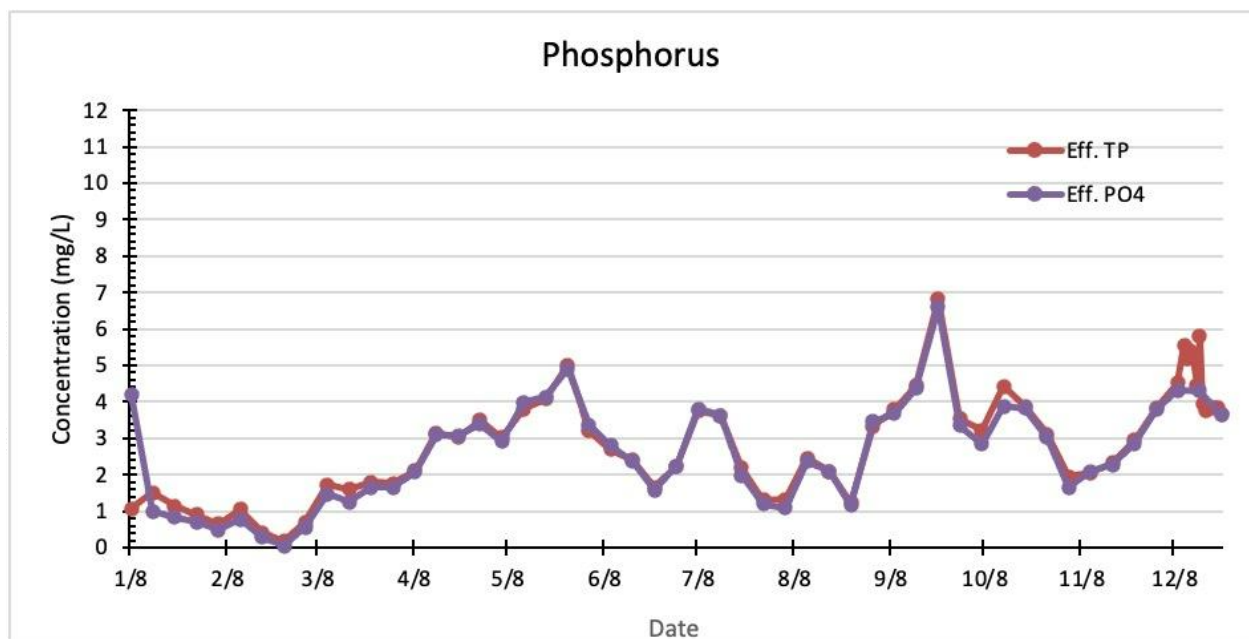


Figure 3. Results of Effluent Phosphorus Removal using Aluminum Salts

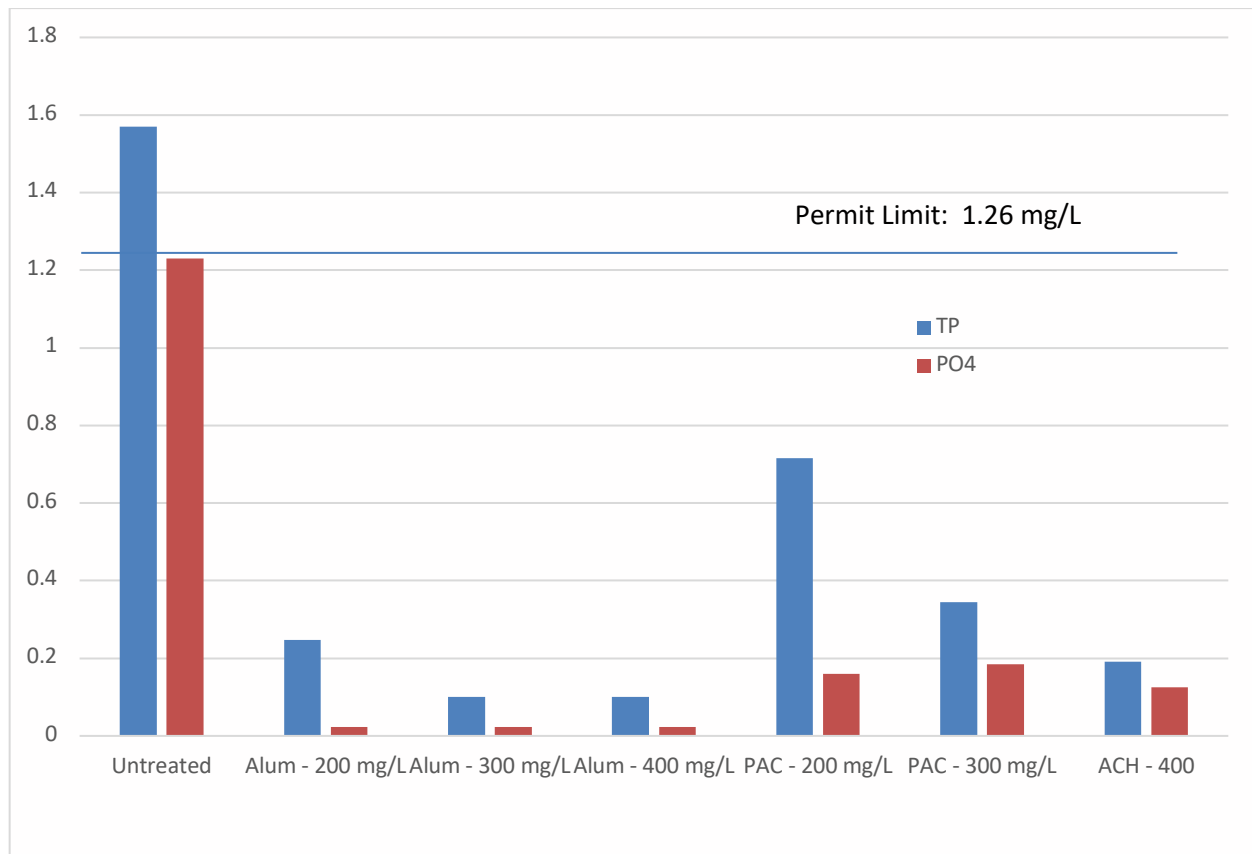
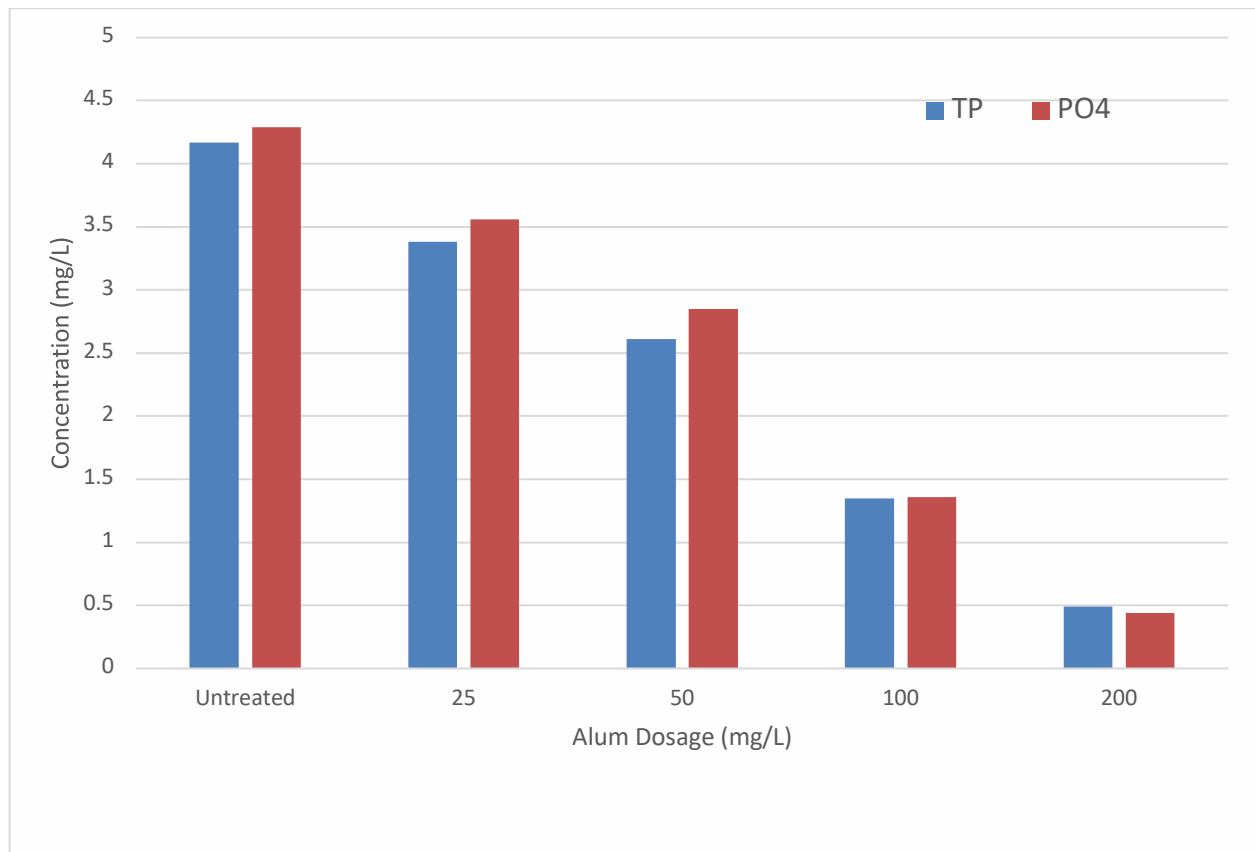


Table 1. Effluent Phosphorus Removal with Aluminum Salts

	TP	PO <sub>4</sub>
Untreated	1.57	1.23
Alum - 200 mg/L	0.248	<0.023
Alum - 300 mg/L	<0.1	<0.023
Alum - 400 mg/L	<0.1	<0.023
PAC - 200 mg/L	0.715	0.16
PAC - 300 mg/L	0.345	0.184
ACH - 400	0.192	0.125

**Table 2. MLSS Phosphorus Removal with Alum**

Alum Dosage (mg/L)	TP	PO <sub>4</sub>
Untreated	4.17	4.29
25	3.38	3.56
50	2.61	2.85
100	1.35	1.36
200	0.49	0.44

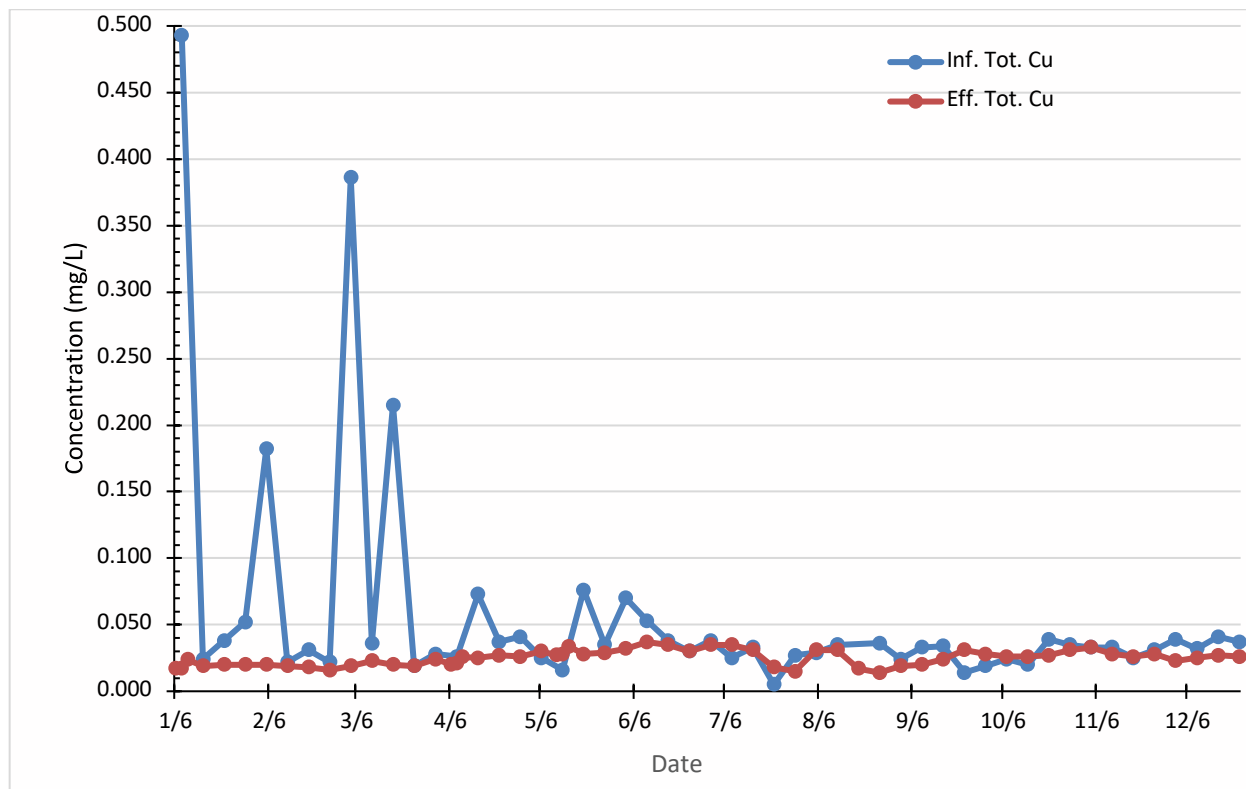
**Figure 4. MLSS Phosphorus Removal using Alum**

## Copper

Currently, Barnhardt is required to only report effluent total copper (Cu) concentrations. However, the limit of 22 µg/L will be in effect at the end of the compliance period. Influent and effluent total copper concentrations are shown in Figure 5. These data were collected for

monitoring purposes and are shown in Appendix B. The average influent Cu concentration was 56 µg/L and the average effluent concentration was 25 µg/L.

**Figure 5. Influent and Effluent Total Copper Concentrations**



Copper analyses performed during the phosphorus removal chemical treatment trials noted above did not indicate any significant copper removal.

In December 2018, the Quality Assurance Project Plan (QAPP) was submitted to MassDEP for conducting water quality monitoring to be used in a Biotic Ligand Model (BLM) to further assess the site-specific copper criteria used to establish the Barnhardt permit limit. Sampling was begun in May 2019. Results have been submitted to EPA and MassDEP for review. Based on the model results, the need for copper removal from the effluent will be further evaluated.

### Toxicity

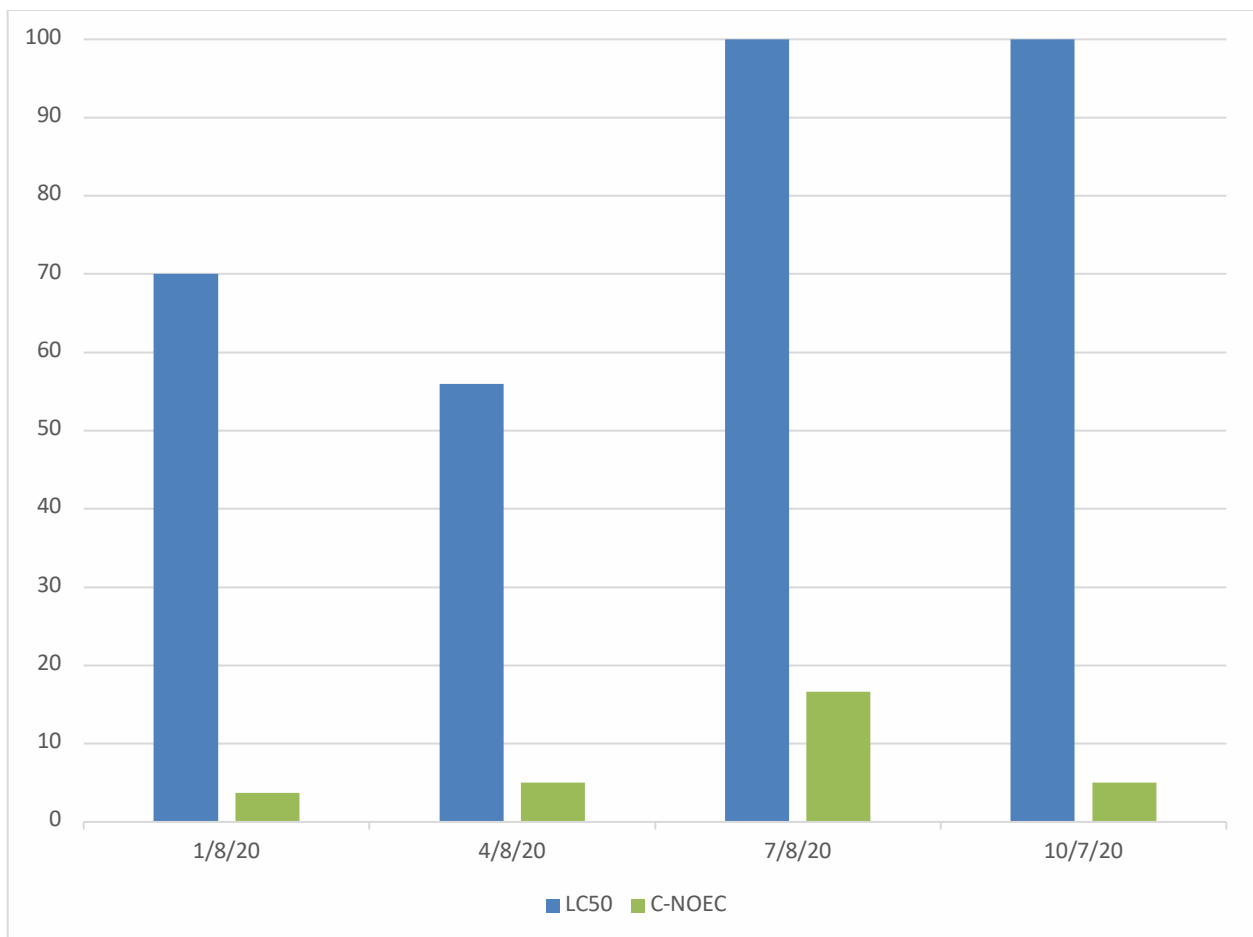
Currently, the permit limit for acute toxicity is an LC<sub>50</sub> of >100% and for chronic toxicity, the No Observed Effect Concentration (C-NOEC) limit is >5%. At the end of the compliance period the

C-NOEC becomes more restrictive with a limit of  $>7.2\%$ . The 2020 test results are shown in Table 3 and Figure 6.

**Table 3. 2019 Toxicity Test Results**

	LC50	C-NOEC
Permit Limits:	$>100\%$	$>5\%$
Date		
1/8/20	70	3.7
4/8/20	56	$<5$
7/8/20	100	16.6
10/7/20	100	$<5$

**Figure 6. 2020 Toxicity Test Results**



Note that the 5% LC<sub>50</sub> values shown in Figure 6 actually represent values of <5% and were not in compliance with the current permit. Acute toxicity levels exceeded (were more toxic) the permit limit during January and April quarters while the chronic limit was exceeded for January, April, and October quarters.

Toxicity identification testing through 2019 has been previously reported. Testing performed during 2020 is presented below.

*Sample Collected 4/9/2020*

A grab composited WWTP effluent sample was collected on 4/9/2020 for toxicity testing of the untreated sample and for evaluation of the impact of hardness adjustment on WET. The untreated chemical characteristics are shown in Table 4.

**Table 4. 4/9/2020 Effluent Characteristics**

Parameter	Units	Results
Alkalinity	mg/L	1540
Ammonia	mg/L	0.432
COD tot	mg/L	241
COD sol	mg/L	192
Conductivity	µmhos/cm	2320
Hardness	mg/L	75.5
TDS	mg/L	1970
pH	S.U.	8.8

**Hardness Adjustment**

The effluent hardness and calcium concentrations are relatively low with historical averages of 69 and 15 mg/L, respectively. The receiving stream hardness averages around 30 mg/L. It is known that calcium may improve the tolerance of *C. dubia* to metal and dissolved solids. To evaluate this, toxicity testing was performed adding 200 mg/L of hardness (as CaSO<sub>4</sub>) to each dilution. The results are shown in Table 5. No improvement in chronic toxicity was observed.

**Table 5. Toxicity results for hardness addition**

Description	Untreated	Hardness +200 mg/L
C-NOEC	<2.5%	<2.5
IC25	0.96%	1.10%
A-NOEC	50	50
LC50	>100	>100

### *Cotton Water Scour Testing*

To evaluate contaminants originating from the cotton being processed, samples of the gin waste material (Regin Rinse) and virgin organic cotton (Organic Wash) were scoured with hot water at 250 °F for 45 minutes and the resulting liquid was tested. Twelve (12) liters of water was used per 1000 grams of fiber. No chemicals were added to the scour baths. The analytical results for these samples are shown in Table 6. Toxicity results are shown in Table 7. The waters from the scour baths demonstrated significant levels of acute toxicity. Due to the high level of acute toxicity observed, chronic toxicity testing was not performed. It should be noted that these samples were not biologically treated and the results indicate only the possibility that effluent toxicity is originating from the cotton.

**Table 6. Cotton Scour Bath Test Results**

<b>Parameter</b>	<b>Units</b>	<b>Organic Wash</b>	<b>Regin Rinse</b>
Alkalinity	mg/L	142	93.4
Ammonia	mg/L	2.17	2.21
COD tot	mg/L	1220	893
COD sol	mg/L	1090	670
Conductivity	µmhos/cm	638	472
Hardness	mg/L	<5	59.2
TDS	mg/L	1150	850
pH	S.U.	7	6.8

**Table 7. Cotton Scour Toxicity Results**

<b>Description</b>	<b>Organic Wash</b>	<b>Regin Rinse</b>
<b>A-NOEC</b>	25	25
<b>LC50</b>	33	38

### *Sample Collected 7/1/2020, pH Adjusted Trial*

A grab composite WWTP effluent sample was collected on 7/1/2020 for toxicity testing of the untreated sample and for evaluation of the impact of pH adjustment on the WET. The untreated and pH adjusted chemical characteristics are shown in Table 8. Toxicity results are shown in Table 9. After reducing the pH to 7.2 S.U. using sulfuric acid, the sample was aerated for 2 hours to remove excess carbon dioxide (CO<sub>2</sub>). As a result, the alkalinity was reduced from 1,230 to 999 mg/L. The TDS increased slightly from 1,920 to 1,940 mg/L. Conductivity increased



from 2,220 to 2,480  $\mu\text{mhos/cm}$ . No toxicity improvement was observed. Both the  $\text{IC}_{25}$  and the  $\text{LC}_{50}$  values decreased.

**Table 8. 7/1/2020 Effluent Characteristics**

Parameter	Units	Untreated	pH Adjusted
Alkalinity	mg/L	1230	999
COD tot	mg/L	197	199
COD sol	mg/L	148	150
Conductivity	$\mu\text{mhos/cm}$	2220	2480
Copper, tot	$\mu\text{g/L}$	33.5	32.5
TDS	mg/L	1920	1940
pH	S.U.	8.8	7.2
Chloride	mg/L	30.8	204
Sodium	mg/L	705	601
Sulfate	mg/L	20.6	60.5

**Table 9. Toxicity results for untreated and pH adjusted sample**

Description	Untreated	pH Adjusted to 7.2
<b>C-NOEC</b>	<2.5	<2.5
<b>IC<sub>25</sub></b>	5	1.2
<b>A-NOEC</b>	50	25
<b>LC<sub>50</sub></b>	>100	29

#### *Defoamer and Sludge Dewatering Polymer*

The use of defoamer containing polydimethylsiloxane (PDMS) and sludge dewatering polymer was discontinued on 7/16/2020. Prior to this date, defoamer had been added to the aeration basin and the final effluent on a continuous basis. Based on an effluent flow of 400,000 gpd, the dosages applied to the aeration basin and final effluent are estimated to have been 1.25 mg/L (0.375 mg/L PDMS) and 0.7 mg/L (0.21 mg/L PDMS), respectively. To evaluate the possible impact of the use of these chemicals on the WET, grab composite samples of the clarifier effluent and the WWTP effluent was collected on 9/2/2020 for toxicity testing. During the testing period, defoamer was added to the effluent at the dosage state above. The analytical results for the samples are shown in Table 10 and the toxicity results are shown in Table 11. The results indicate some improvement in chronic toxicity with C-NOEC values at concentrations above the permit limit.

While these results were encouraging, it is noted that while the plant had been operating for the two weeks prior to sampling, manufacturing operations had been intermittent due market conditions. Additional testing performed on the WWTP effluent in October (see Table 3) reported a C-NOEC of <5%. Thus, elimination of the defoamer and sludge dewatering polymer did not reduce the chronic toxicity.

**Table 10. Analytical results for clarifier effluent and WWTP effluent samples collected on 9/2/2020.**

Parameter	Units	Clarifier Eff.	WWTP Eff.
Alkalinity	mg/L	893	861
Ammonia	mg/L	0.226	0.223
Hardness	mg/L	51	53
TDS	mg/L	1340	1330
TSS	mg/L	<3	<3

**Table 11. Toxicity results for clarifier effluent and WWTP effluent samples collected on 9/2/2020.**

Description	Clarifier	
	Eff.	WWTP Eff.
<b>C-NOEC</b>	25%	25%
<b>IC25</b>	28%	26%
<b>A-NOEC</b>	50%	50%
<b>LC50</b>	>100%	>100%

#### *Herbicide and Pesticide Testing*

Due to the high level of toxicity being exhibited and the lack of success in identifying the toxicants or treatment alternatives, the influent and effluent were tested for a wide range of pesticides as well as glyphosate and paraquat used in herbicides. Influent and effluent samples were collected on 6/10/2020 and shipped to Environmental Micro Analysis, Inc. for testing. Of the several hundred pesticides included in the GC/MS and LC/MS libraries used, none were detected. Glyphosate was detected in the WWTP influent at a concentration of 11.6 µg/L but was not detected in the effluent. Paraquat was not detected. Based on these results, it is not likely that the observed toxicity is caused by pesticides or herbicides applied to the cotton being processed at the time of sampling.

#### *Bleaching Process Changes*

Changes in the bleaching process are being implemented that should reduce the amount of caustic, acid and peroxide used. WWTP effluent toxicity testing will be performed during the 1<sup>st</sup> quarter of 2021 to evaluate the effect of these changes.

### *Summary Toxicity Reduction Evaluations*

Toxicity is an on-going concern for BMC and testing has been performed in an effort to identify the cause. Acute and chronic toxicity testing has been performed following various treatments in an effort to identify the class of contaminants contributing to effluent toxicity. The treatments provided were:

1. Filtration with 0.45micron ( $\mu\text{m}$ ) filter to remove colloidal materials;
2. Ethylenediaminetetraacetic acid (EDTA) treatment to chelate copper and other metals;
3. Activated carbon treatment to remove organics and other adsorbable material;
4. Chemical coagulation to remove organics and colloidal materials;
5. Calcium addition to increase hardness; and
6. Adjustment of pH to reduce alkalinity.

None of these treatments significantly reduced toxicity.

The use of process chemicals was evaluated resulting in the elimination and replacement of one scouring agent and some reduction in the amount of caustic used in bleaching and acid used for neutralization. These changes also failed to reduce the levels at which toxicity is observed. In addition, pesticides were not found in the WWTP influent or effluent. Only a trace of glyphosate, an ingredient found in many herbicides, was detected in the WWTP influent. However, it was not detected in the effluent. Finally, the use of defoamer and sludge dewatering polymer was curtailed to evaluate their potential impact on toxicity. However, no improvement was observed based on WWTP effluent test results.

### **Conclusion**

Compliance with the phosphorus limit appears to be achievable by precipitation with alum. In the event that the BLM does not justify higher site-specific limits for copper resulting in permit compliance, additional chemical treatment or source reduction may be needed for this parameter. Toxicity reduction is the most challenging issue in that neither the cause of toxicity nor a treatment method to reduce the toxicity have been identified. Additional work is being performed to evaluate the effect of changes in the bleaching process on effluent toxicity.

If you have any questions or need additional information, please feel to contact Mr. Wade Hubbard or Mr. Greg Morand at the numbers shown below.

Wade Hubbard, Barnhardt Mfg., Phone: 704-376-0380

Greg Morand, Omni Environmental, Phone: 978-256-6766, Ext. 102

Sincerely,

A handwritten signature in cursive script that reads "W. Gilbert O'Neal".

W. Gilbert O'Neal, Ph.D., P.E.  
President

Cc: Greg Morand, Omni Environmental Group  
Wade Hubbard, Barnhardt Mfg.  
Lewis Barnhardt, Barnhardt Mfg.  
MASS-DEP Western Region, Bureau of Water Resources

## Appendix A. 2020 Phosphorus Data

SampleDate	Inf. TP	Eff. TP	Inf. PO4	Eff. PO4
1/8/2020	2.46	1.06	1.92	4.21
1/15/2020	1.38	1.5	0.711	1
1/22/2020	7.85	1.14	5.6	0.836
1/29/2020	7.25	0.909	5.3	0.703
2/5/2020	4.66	0.655	2.7	0.486
2/12/2020	1.8	1.05	0.659	0.78
2/19/2020	4.17	0.415	2.56	0.292
2/26/2020	1.4	0.172	0.575	0.041
3/4/2020	5.3	0.701	3.13	0.551
3/11/2020	5.2	1.72	3.41	1.47
3/18/2020	4.28	1.6	1.75	1.26
3/25/2020	1.49	1.8	0.461	1.65
4/1/2020	5.71	1.77	3.89	1.65
4/8/2020	6.9	2.11	3.49	2.08
4/15/2020	4.88	3.14	2.47	3.09
4/22/2020	8.33	3.02	4.8	3.08
4/29/2020	7.8	3.5	4.16	3.39
5/6/2020	6.53	3.02	3.19	2.92
5/13/2020	5.3	3.81	2.54	3.98
5/20/2020	4.1	4.08	1.14	4.13
5/27/2020	5.64	5.01	2.36	4.9
6/3/2020	7.19	3.2	3.71	3.36
6/10/2020	6.82	2.7	3.34	2.8
6/17/2020	7.46	2.4	3.67	2.37
6/24/2020	2.87	1.66	0.612	1.58

---

7/1/2020	4.76	2.23	1.71	2.23
7/8/2020	0.31	3.75	0.113	3.81
7/15/2020	3.62	3.62	1.17	3.62
7/22/2020	0.097	2.19	0.028	1.99
7/29/2020	5.9	1.3	2.33	1.19
8/5/2020	6.16	1.33	3.81	1.09
8/12/2020	5.13	2.45	2.5	2.37
8/19/2020		2.09		2.09
8/26/2020	6.38	1.23	3	1.16
9/2/2020	6.74	3.33	4.76	3.46
9/9/2020	6.19	3.79	3.33	3.68
9/16/2020	5.95	4.44	3.2	4.38
9/23/2020	2.64	6.82	1.33	6.6
9/30/2020	4.25	3.53	2.7	3.35
10/7/2020	5.16	3.23	2.36	2.84
10/14/2020	3.34	4.42	1.59	3.88
10/21/2020	6.71	3.87	4.1	3.82
10/28/2020	8.01	3.12	2.96	3.03
11/4/2020	5.87	1.95	2.78	1.65
11/11/2020	7.94	2.05	4.97	2.09
11/18/2020	6.36	2.32	3.98	2.28
11/25/2020	7.76	2.94	4.43	2.85
12/2/2020	9.67	3.83	5	3.78
12/9/2020	6.9	4.51	3.22	4.31
12/11/2020	0.917	5.55		
12/12/2020	0.341	5.2		
12/13/2020	4.33	5.4		
12/14/2020	8.41	5.25		
12/15/2020	8.83	4.44		

12/16/2020	9.18	5.79	5	4.3
12/17/2020	3.79	3.96		
12/18/2020	0.321	3.76		
12/19/2020	0.25	3.87		
12/20/2020	5.62	3.82		
12/21/2020	5.62	3.82		
12/22/2020	5.62	3.82		
12/23/2020	6.52	3.66	3.57	3.64
12/30/2020	6.58	3.78	2.63	3.77
Average	5.14	2.99	2.84	2.61
Max.	9.67	6.82	5.60	6.60
Min.	0.10	0.17	0.03	0.04
% of Total			0.87279307	

## Appendix B. Influent and Effluent Copper Data

SampleDate	Inf. Tot. Cu	Eff. Tot. Cu	Eff. Sol. Cu
1/6/2020		0.0174	
1/8/2020	0.493	0.0174	
1/10/2020		0.0239	
1/15/2020	0.024	0.019	0.017
1/22/2020	0.038	0.02	0.018
1/29/2020	0.052	0.02	0.017
2/5/2020	0.182	0.02	0.018
2/12/2020	0.022	0.019	0.015
2/19/2020	0.031	0.018	0.017
2/26/2020	0.022	0.016	0.02
3/4/2020	0.386	0.019	0.017
3/11/2020	0.036	0.023	0.019
3/18/2020	0.215	0.02	0.021
3/25/2020	0.019	0.019	0.02
4/1/2020	0.028	0.024	0.024
4/6/2020		0.0203	
4/8/2020	0.026	0.021	
4/10/2020		0.0257	
4/15/2020	0.073	0.025	0.024
4/22/2020	0.037	0.027	0.026
4/29/2020	0.041	0.026	0.025
5/6/2020	0.025	0.03	
5/11/2020		0.0271	
5/13/2020	0.016	0.028	0.029
5/15/2020		0.0337	



---

5/20/2020	0.076	0.028	0.029
5/27/2020	0.035	0.029	0.028
6/3/2020	0.07	0.032	0.031
6/10/2020	0.053	0.037	0.029
6/17/2020	0.038	0.035	0.034
6/24/2020	0.03	0.03	0.028
7/1/2020	0.038	0.035	0.033
7/8/2020	0.025	0.035	0.034
7/15/2020	0.033	0.031	0.031
7/22/2020	0.005	0.018	0.018
7/29/2020	0.027	0.015	0.015
8/5/2020	0.029	0.031	0.03
8/12/2020	0.035	0.031	0.028
8/19/2020		0.017	0.016
8/26/2020	0.036	0.014	0.014
9/2/2020	0.024	0.019	0.019
9/9/2020	0.033	0.02	0.02
9/16/2020	0.034	0.024	0.025
9/23/2020	0.014	0.031	0.028
9/30/2020	0.019	0.028	0.026
10/7/2020	0.024	0.026	0.023
10/14/2020	0.02	0.026	0.027
10/21/2020	0.039	0.027	0.026
10/28/2020	0.035	0.031	0.029
11/4/2020	0.033	0.033	0.032
11/11/2020	0.033	0.028	0.028
11/18/2020	0.025	0.026	0.026
11/25/2020	0.031	0.028	0.027
12/2/2020	0.039	0.023	0.021

12/9/2020	0.032	0.025	0.028
12/16/2020	0.041	0.027	0.022
12/23/2020	0.037	0.026	0.024
12/30/2020	0.022	0.025	0.024
Average	0.056	0.025	0.024
Max.	0.493	0.037	0.034